REMARKS

By the present amendment, claims 1-4, 6 and 8-16 are pending in the application. Claims 1-4 are independent claims.

SUPPORT FOR AMENDED CLAIMS

Claims 1 to 4

In amended independent claims 1 to 4, the contents of C, Si, Mn, P, S, Al, B and Ti are supported by original dependent claim 7. The balance being Fe and unavoidable impurities is disclosed in the specification, e.g., at page 17 lines 3-4.

Support for --Si amount is controlled in a range from (Mn/8 - 0.07) to (Mn/8 + 0.07)-- may be found in original claim 5.

In amended independent claims 1 to 4, support for the limitation --not more than 0.5% Cr-- is disclosed in the specification, e.g., at page 4, lines 19-23. Cr is disclosed as a arbitrary component (not necessary) in the steel composition (page 4, line 19) and the maximum amount of Cr, if present in the steel composition, is 0.5% Cr (page 4, line 22). Thus, there is either no Cr in the steel composition or if Cr is present in the steel composition, the maximum Cr is limited to 0.5%.

Many examples of the steel composition of the steel pipe of the present invention at Table 1, page 14 and Table 3, page 16 of the specification disclose no Cr in the steel composition.

In amended claims 1 to 4, support for the claim limitation --not more than 0.5% Mo-- is disclosed in the specification, e.g., at page 4, lines 19-23. Mo is disclosed as an arbitrary component (not necessary) in the steel composition (page 4, line 19) and the maximum amount of Mo, if present in the steel composition, is 0.5% Mo (page 4, line 22).

Thus, there is either no Mo in the steel composition or if Mo is present in the steel composition, the maximum amount of Mo is limited to 0.5%.

No examples of the steel composition of the steel pipe of the present invention at Table 1, page 14 and Table 3, page 16 of the specification disclose Mo in the steel composition.

Claim 6

The high dislocation density of dependent claim 6 is the result of rapid cooling caused by water quenching of the induction heated steel. See specification page 9, line 1 to page 10, line 9. See, e.g., page 9, lines 14-19 which discloses water quenching causes the transformation of austenite to martensite to occur instantaneously and the dislocation density of the martensite structure increases drastically. Page 9, lines 32-35 discloses that the high dislocation density results in low YS and maintains a high TS. Page 9, line 36 to page 10, line 3 discloses that water quenching at 100°C/sec (6,000°C/min) or higher results in high TS and low YR.

Claims 8 to 11

The dependencies of dependent claims 8 to 11 and 13 have been revised.

Claim 9

Dependent claim 9 has been amended to make it a clear product claim by deleting process type limitations from the claim.

Claim 14

New dependent method claim 14 is based upon original dependent claim 9.

Claim 15

The maximum Mn content of 1.44% in new dependent claim 15 is supported by the inventive examples in Table 1 at page 14 of the specification and Table 3 at page 16 of the specification where 1.44% Mn is the highest Mn content of the inventive examples.

Claim 16

The maximum Cr content of 0.15% Cr in new dependent claim 16 is supported by the inventive examples in Table 1 at page 14 of the specification and Table 3 at page 16 of the specification where 0.15 % Cr is the highest Cr content of the inventive examples.

TENSILE STRENGTH

The present invention is directed to a low YR (yield ratio) in combination with a very high TS (tensile strength) achieved by the specific steel composition of the present invention with the steel pipe being water quenched after heat treatment. The minimum tensile strength of independent claims 1 to 4 is as follows.

claim 1	-	1700 MPa	=	173.9 kgf/mm^2
claim 2	-	1800 MPa	=	183.5 kgf/mm^2
claim 3	-	1900 MPa	=	193.7 kgf/mm^2
claim 4	-	2000 MPa	=	203.9 kgf/mm^2

The conversion factor is l kgf/mm^2 = 9.81 MPa or MPa/9.81 = kgf/mm^2.

THE REJECTIONS

In the Office Action mailed June 21, 2005, claims 1 and 5 to 10 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 6-179945.

Claims 1, 2, 5, 6, 9 and 10 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 5,374,322 to Okada et al.

Claims 3, 4, 7, 8 and 10 to 13 were rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,374,322 to Okada et al.

These rejections, as applied to the amended claims, are respectfully traversed.

INTERVIEW SUMMARY

The applicants and the applicants' attorney thank the Examiner for the courtesy of the interview on November 15, 2005. The following is a summary of the topics discussed at the interview.

Exhibits

There were no exhibits shown and there were no demonstrations conducted at the interview.

Claims

All claims were discussed in the interview. These included original claims 1 to 13 and new proposed amended claims 1 to 4, 6, and 8-16. A copy of the new proposed claims discussed is attached to the Examiner's Interview Summary (PTOL-413).

Prior Art

The specific prior art discussed in detail was Japan No. 6-179945 and U.S. Patent No. 5,374,322 to Okada et al.

Proposed Amendments

The proposed amendments discussed are the amendments to the claims set forth in the Listing Of The Claims of this amendment. These amendments are also shown in the new proposed claims attached to the Examiner's Interview Summary (PTOL-413).

SUPPORT FOR CLAIM AMENDMENTS

The first topic discussed in the interview was support in the original disclosure for the new proposed claim amendments.

Amended Claims 1 to 4

Steel Pipe Composition

The steel composition for the steel pipe of dependent claim 7 (C, Si, Mn, P, S, Al, B and Ti) has been added to independent claims 1, 2, 3 and 4. Dependent claim 7 describes the C, Si, Mn, P, S, B and Ti contents of the steel composition claimed as indispensable. See also specification at page 4, lines 15-19. These indispensable chemical components should be distinguished from Cr and Mo which are arbitrary (not necessary) chemical components of the steel composition. See specification page 4, lines 19-23.

The range of Mn in the steel composition of the steel pipe in amended independent claims 1, 2, 3 and 4 is 0.5 to 1.60% Mn. The range of 0.5 to 1.60% Mn appears in original dependent claim 7.

The limitations of "not more than 0.5% Cr" and "not more than 0.5% Mo" have been added to the steel composition of independent claims 1, 2, 3 and 4. Since Cr and Mo are arbitrary chemical components (specification page 4, line 19), there can be no (0%) Cr and/or no (0%) Mo in the composition of the steel. The maximum of 0.5% Cr and the maximum of 0.5% Mo are disclosed in the specification at page 4, lines 21-22.

The limitation of independent 5, "the Si amount in the steel of said steel pipe is controlled in a range from Mn/8 - 0.07 to Mn/8 + 0.07 (mass %)", has been added to amended independent claims 1, 2, 3 and 4.

The steel composition of amended independent claims 1, 2, 3 and 4 is defined by the phrase "consisting essentially of".

<u>0.5 to 1.60% Mn</u>

A reason for adding the claim limitation of --<u>0.5 to 1.60 Mn</u>-- to independent claims 1, 2, 3 and 4 is to distinguish over JP-179945 ("JP '945") and U.S. Patent No. 5,374,322 to Okada et al. ("US '322").

The technology of JP '945 is directed to a steel pipe having a steel composition containing 2.0 to 3.0 wt% (mass %) Mn.

US '322 and JP '945 do not disclose or suggest a steel pipe having a tensile strength TS of 1,700 MPa or more when the composition of the steel contains 0.5 to 1.60 % Mn, not more than 0.5% Cr and not more than 0.5% Mo. This will hereinafter be discussed in detail.

<u>Not More Than 0.5% Cr</u>

A reason for adding the claim limitation of --<u>not more than 0.5% Cr</u>-- to independent claims 1 to 4 is to have an express claim limitation that distinguishes over the disclosure of cited U.S. Patent No. 5,374,322 to Okada et al. (US '322). Col. 4, line 29 of US '322 discloses 1.0 - 3.5% Cr in the steel composition of US '322. Col. 6, lines 40-44 of US '322 discloses:

> Cr <u>is essential</u> to the present invention in which a long pipe is quenched by cooling at a cooling rate corresponding to that of <u>air cooling</u> with distortions caused by quenching being greatly suppressed <u>compared with</u> those caused by <u>water quenching</u>.

In addition to the disclosure of 1.0 - 3.5% Cr at Col. 4, line 29 of US '322, US '322 discloses 1.0 to 3.5% Cr at Col. 6, lines 44-49 and independent claims 1 and 4 of US '322 claim 1.0 - 3.5% Cr. In addition, all the steel types of Table 1 at Cols. 11-12 of US '322 disclose more than 1.0% Cr except steel type A13. Steel type A13 is identified as a

conventional steel which contains 0.68% Cr (greater than 0.5% Cr) and 1.86% Mn (greater than 1.60% Mn).

Thus, it is clear that US '322 teaches a steel which contains 1.0 to 3.5% Cr as an essential component of the steel composition.

Thus the claim limitation of --not more than 0.5% Cr-- added to independent claims 1 to 4 is an express claim limitation distinguishing over the disclosure of US '322. The minimum Cr content of the steel of US '322 is twice the maximum Cr content permitted (but not required) in the steel of the present invention.

Furthermore, the claim limitation --not more than 0.5% Cr-- added to independent claims 1 to 4 is an express claim limitation distinguishing over comparative Example 2 of Table 1 of cited Japan No. 6-179945 which requires 2% Cr.

The specification of the present application discloses at page 8, lines 22-23 that when Cr is excessively added to the steel composition, segregated inclusions are formed. The addition of Cr also increases cost. Specification, page 8, line 22.

Not More Than 0.5% Mo

A reason for adding the claim limitation of --not more than 0.5% Mo-- to independent claims 1 to 4 is to have an express claim limitation that distinguishes over comparative Example 1 and comparative Example 3 of Table 1 of JP 6-179945 ("JP '945"). Example 1 of Table 1 of JP '945 requires 2.0% Mo. Example 3 of Table 1 of JP '945 requires 1.5% Mo. Furthermore, Example 11 of JP '945 requires 1.0% Mo.

The claim limitation of --not more than 0.5% Mo-- added to independent claims 1 to 4 is an express claim limitation which distinguishes over Example 1, Example 3 and Example 11 of Table 1 of JP '945.

The specification of the present application discloses at page 8, lines 22-23 that when Mo is excessively added to the steel composition, segregated inclusions are formed. The addition of Mo also increases cost. Specification, page 8, line 22.

<u>Claim 5 (canceled)</u>

Independent claim 5 has been canceled. The limitations of dependent claim 5 has been placed in amended independent claims 1, 2, 3 and 4.

<u>Claim 6</u>

Dependent claim 6 remains unchanged and is directed to the dislocation density of 10^{10} to $10^{14}/mm^{-2}$.

<u>Claim 7 (canceled)</u>

Dependent claim 7 has been canceled. The limitations of dependent claim 7 have been placed in amended independent claims 1, 2, 3 and 4.

<u>Claim 8</u>

The phrase --consists essentially of-- has been used to define the steel composition of dependent claim 8.

<u>Claim 9</u>

In dependent claim 9, method type claim limitations have been deleted so that dependent claim 9 is clearly a product claim.

A dependent method claim 14 has been added which incorporates the method type claim limitations of original dependent claim 9.

<u>Claim 10</u>

Dependent claim 10 is unchanged and is directed to the shape of the steel pipe.

<u>Claim 11</u>

The phrase --consists essentially of-- has been used to define the steel composition in dependent claim 11.

Claim 11 is a dependent method claim which is directed to induction heating and then water quenching of the steel pipe having the defined composition.

Claim 12

Dependent claim 12 is a method claim which is unchanged and which is directed to the cooling rate of water quenching of claim 11 having a cooling rate of 100°C/sec or higher.

Claim 13

Dependent claim 13 is a method claim which is unchanged and which is directed to the cooling water temperature of the water quenching being 35°C or lower.

Claim 14

As previously discussed, new dependent method claim 14 is based upon the method type claim limitations of original dependent claim 9.

Claim 15

New dependent claim 15 has been introduced which is directed to a maximum Mn content of 1.44%. This is based upon the maximum Mn content of the inventive examples of Table 1 and Table 3 of the specification. This further distinguishes the Mn content of the present invention over JP '945.

Claim 16

New dependent claim 16 is directed to a maximum Cr content of 0.15%. This is based upon the maximum Cr content of the inventive examples of Table 1 and Table 3 of the specification. This further distinguishes the Cr content of the present invention over US '322.

THE PRESENT INVENTION

In the interview, it was pointed out that the present invention is directed to the following combination of features.

1. A steel composition for the pipe which includes 0.5 to 1.60% Mn wherein the presence of Cr and Mo in the steel composition is arbitrary. That is the steel composition of the pipe can contain 0% Cr and 0% Mo. If Cr is present in the steel composition of the pipe of the present invention, the maximum Cr permitted is 0.5%. If Mo is present in the steel composition of the pipe of the present invention, the maximum Mo permitted is 0.5%.

2. The present invention has a low YR (yield ratio) in combination with a very high TS (tensile strength). The minimum tensile strength of independent claims 1 to 4 is as follows.

claim 1	-	1700 MPa	=	173.9 kgf/mm^2
claim 2	-	1800 MPa	=	183.5 kgf/mm^2
claim 3	-	1900 MPa	=	193.7 kgf/mm^2
claim 4	-	2000 MPa	=	203.9 kgf/mm^2

The conversion factor of 1 kgf/mm^2 = 9. 81 MPa or MPa/9.81 = kgf/mm^2 was used.

3. The very high TS of the present invention is the result of the claimed chemical composition of the steel of the pipe as set forth in independent claims 1 to 4 in combination with heat treating of the pipe followed by water quenching. Water quenching is particularly important. Induction heating is a disclosed preferred heat treatment.

The cooling rate of water quenching in approximately 100°C/sec (6,000°C/min) or higher, which results in the very high TS and low YR. Specification, page 9, line 37 to page 10, line 3. Fig. 2 of the specification of the present application illustrates

that water cooling (approximately 100°C/min or 6,000°C/sec or greater) has a very significant effect on yield ratio (YR) at 0.1% proof stress as compared to 0.2% proof stress.

The Examples of the present invention at Table 2, page 14 of the specification disclose water quenching cooling rates of 150 to 200°C/sec (9,000 to 12,000°C/min).

The water quenching causes an instantaneous transformation from austenite to martensite and the dislocation density in the martensite structure increases drastically. Specification, page 9, lines 14-19.

The high dislocation density caused by the water quenching lowers the yield point (YS) while a higher TS is maintained. Specification, page 9, lines 28-36. The dislocation density of the present invention is 10^{10} - 10^{14}/mm^{-2}.

4. The high tensile strength (TS) defined in independent claims 1 to 4 is the result of water quenching of the heat treated steel pipe having the steel composition defined in independent claims 1 to 4.

The water quenching of the present invention results in the high dislocation density of the present invention, 10^{10} - 10^{14}/mm^{-2}, which is set forth in dependent claim 6. The high dislocation density of the present invention results in the high tensile strength (TS) of the present invention.

5. The cited prior art, JP 6-179945 ("JP '945") and U.S. Patent No. 5,374,322 ("US '322) does not disclose or suggest the steel pipe composition of claims 1 to 4.

6. The cited prior art, JP '945 and US '322, teaches air cooling, not water quenching. Air cooling provides a cooling rate of at most a few 100°C/min. Water quenching, in accordance with the present invention, provides a cooling rate of 6,000°C/min (100°C/sec) or higher. Specification, page 9, line 37 to page 10, line 3.

7. The cited prior art, JP '945 and US '322, does not disclose or suggest a steel pipe which has, in combination, (i) the steel composition defined in independent claims 1 to 4 and (ii) a tensile strength (TS) of 1700 MPa (173.9 kgf/mm^2) or higher.

8. The cited prior art, JP '945 and US '322, does not disclose or suggest a method to make a steel pipe defined in independent claims 1 to 4 because JP '945 and /or US '322 do not disclose or suggest a steel pipe having the composition required by independent claim 1 to 4 or water quenching a heat treated steel pipe having the composition required by independent claims 1 to 4 to obtain a steel pipe having a very high tensile strength (TS) of 1700 MPa or greater in combination with a low yield ratio (YR) required by independent claims 1 to 4. The present invention has both a very high tensile strength (TS) and a low yield ratio (YR).

CLARIFICATIONS - JP '945

In the interview it was pointed out that the Japanese patent attorneys handling this case provided the following clarifications with respect to the disclosure of Japan No. 6-179945.

Table 1

Examples 1, 2 and 3 of Table 1 of JP '945 appearing at page 5 [0027] of JP '945 are comparative examples. Examples 4 to 18 of Table 1 of JP '945 are examples of the technology disclosed in JP '945. This also applies to Table 2 at page 6 [0028] of JP '945.

This information was not expressly included in the computer English translation of JP '945 provided by the PTO.

Table 2

The computer English translation of JP '945 provided by the PTO did not translate the headings of the columns of Table 2 (page 6 [0028]) of JP '945. The columns of Table 2 (page 6 [0028]) of JP '945 are directed to the following parameters.

Col. 1 -	Example number.
Col. 2 -	Hot rolling finishing temperature (°C).
Col. 3 -	Coiling temperature (°C).
Col. 4 -	Heat treatment temperature for ERW pipe.
Col. 5 -	Cold working ratio (%).
Col. 6 -	Final heat treatment for the cold worked pipe.
Col. 7 -	Tensile strength (TS) of a steel plate prior to being manufactured into a pipe. Thus, in Example 1, Col. 7 of Table 2 discloses that a steel plate has a tensile strength (TS) of 125 kgf/mm^2 prior to being manufactured into a steel pipe.
Col. 8 -	Tensile strength (TS) of the final steel pipe product. Thus, in Example 1, Col. 8 of Table 2 discloses that the final steel pipe product has a tensile strength of 152 kgf/mm^2.
Col. 9 -	Elongation of the final steel pipe product (%).
Col. 10-	Yield ratio (YR) of the final steel pipe product. Thus, in Example 1, Col. 10 of Table 2 discloses that the final Steel pipe product has a yield ratio (YR) of 0.80.

[0024]

In paragraph [0024] of JP '945, the cooling rate parameter is 10-150°C/min. The computer English translation states "10-150-degree-C/. The computer English translation does not translate the parameter as °C/min which appears in the original Japanese.

PATENTABILITY OVER PRIOR ART

In the interview, the following detailed arguments were present for showing the patentability of the amended claims over the cited prior art applied to reject the claims.

Japan No. 6-179945

Composition and Cooling

JP '945 teaches a steel pipe which has a steel composition which contains 2.0 - 3.0 wt% (or mass %) Mn. See claims 1, 2 and [0013] of JP '945. The computer English translation of [0013] of JP '945 discloses that Mn is required in an amount of at least 2.0% or more in order to obtain a good reinforcement and ductility balance, raise the reinforcement and to secure elongation. In JP '945, claim 1 and the English abstract disclose a tensile strength (TS) of 150 to 180 kgf/mm^2, but this tensile strength is disclosed in combination with Mn in the range of 2.0 to 3.0 wt %, which is outside the Mn range of the present invention (0.5 to 1.60 mass % Mn).

In the computer translation of JP '945, [0006] is the Means For Solving The Problem. This is followed by [0007] of the computer translation which discloses 2.0 - 3.0 wt% (mass%) Mn, a Cr - Mo system and the organization of martensite and banite by normalizing. The English Abstract of JP '945 discloses the Title of JP '945 as "Chromium - molybdenum system, electric welded steel pipe ...". The English Abstract of JP '945 discloses 2.0 - 3.0% Mn and a structure of martensite and banite obtained by normalizing.

It is thus clear that 2.0 to 3.0% Mn is essential to the technology of JP '945. The present invention, defined in independent claims 1 to 4, is directed to 0.5 - 1.60% Mn.

JP '945 is directed to a Cr - Mo system. This technology of JP '945 is different from the present invention where Cr and Mo are arbitrary components of the steel composition.

JP '945 teaches normalizing or air cooling of the steel. See discussion above. The art understands normalizing to mean annealing followed by air cooling, particularly cooling in still air or natural cooling.

In the present invention, there is water quenching of the heat treated steel pipe. Water quenching results in a cooling rate of about 100°C/sec (6,000°C/min) or more which is very different from normalizing or air cooling which at most has a cooling rate of a few 100°C/min. The Examples of the present invention at Table 2, page 14 of the specification disclose water quenching cooling rates of 150 to 200°C/sec (9,000 - 12,000°C/min). As previously discussed, the water quenching of the present invention is directly related to the very high tensile strength (TS) of the present invention. The water quenching of the present invention results in the high dislocation density of 10^{10} to $10^{14}/mm^{-2}$ which is directly related to very high tensile strength (TS) and low yield rate (YR). See again specification page 9, line 14 to page 10, line 9.

Comparative Examples of JP '945

Comparative Examples 1 to 3 at Tables 1 and 2 of JP '945 disclose the following.

	Mn	Mo	Cr	TS
Ex. 1	1.30	2.0	0.5	152 kgf/mm^2
Ex. 2	1.60	0.5	2	155 kgf/mm^2
Ex. 3	1.60	1.5	0.0	155 kgf/mm^2

Comparative Examples 1 and 3 of JP '945 disclose 2.0% Mo or 1.5% Mo. This is outside the maximum permitted Mo of 0.5% specified in independent claims 1 to 4. Comparative Example 2 of JP '945 discloses 2% Cr. This is outside the maximum permitted Cr of 0.5% specified in independent claims 1 to 4.

Therefore, Comparative Examples 1, 2 and 3 of JP '945 do not disclose or suggest the steel pipe composition of the present invention defined in independent claims 1 to 4.

The minimum tensile strength (TS) claimed, in accordance with the present invention, is 173.9 kgf/mm^2 (1700 MPa) claimed in independent claim 1. Comparative Examples 1, 2 and 3 of JP '945 disclose tensile strengths of 152, 155 and 155 kgf/mm^2.

Comparative Examples 1, 2 and 3 of JP '945 do not disclose or suggest the steel composition of the present invention or a minimum tensile strength (TS) of 173.9 kgf/mm^2 (1700 MPa) required by the present invention.

Examples of JP '945

The Examples of the technology of JP '945 are Examples 4 to 18 of Tables 1 and 2. All of Examples 4 to 18 of Tables 1 and 2 of JP '945 disclose Mn in a range of 2.0 to 3.0% Mn. This is outside the range of Mn claimed for the steel composition of independent claims 1 to 4 which claim 0.5 to 1.60 % Mn. The upper limit of 1.60 % Mn, in accordance with the present invention, is claimed in originally filed dependent claim 7.

Page 7, lines 30-32 of the specification discloses that when the upper limit of the Mn range of the present invention is exceeded, baking cracks and segregation are undesirably caused.

Therefore, Examples 4 to 18 of the technology of JP '945 do not disclose or suggest the steel pipe composition of the present invention defined in independent claims 1 to 4.

All of Examples 4 to 18 of Tables 1 and 2 of JP '945 disclose a tensile strength (TS) of less than 173.9 kgf/mm^2 (1700 MPa) except Example 11 which discloses a tensile strength (TS) of 180 kgf/mm^2.

However, the composition of Example 11 of JP '945 contains 2.50% Mn and 1.0% Mo which are outside the range of 0.5 to 1.60% Mn and not more than 0.5% Mo claimed by independent claims 1 to 4.

JP '945 does not disclose or suggest a steel pipe with the composition in accordance with the present invention having a tensile strength (TS) of 173.9 kgf/mm^2 (1700 MPa) or greater. JP '945 does not disclose or suggest how to make a steel pipe with the composition defined in independent claims 1 to 4 having a tensile strength (TS) of 173.9 kgf/mm^2 (1790 MPa) or greater because JP '945 does not disclose or suggest water quenching of a heat treated steel pipe having a steel composition in accordance with the present invention. JP '945 teaches normalizing or air cooling a heat treated steel pipe which does not have the defined composition of the present invention.

Note, Example 11 of JP '945 does not disclose or suggest a tensile strength of 183.5 kgf/mm^2 or greater (claim 2 - 1800 MPa); a tensile strength of 193.7 kgf/mm^2 or greater (claim 3 - 1900 MPa) or a tensile strength of 203.9 kgf/mm^2 (claim 4 - 2000 MPa).

JP '945 does not disclose or suggest the very high dislocation density of 10^{10} to $10^{14}/mm^{-2}$ of dependent claim 6. The very high dislocation density of the present invention is the result of water quenching and the very high dislocation density of the present invention results in the very high tensile strength (TS) and low yield ratio (YR) of the present invention. JP '945 teaches normalizing of a heat treated steel pipe.

U.S. Patent No. 5,374,322

Cr Essential

US '322 discloses a steel member having a composition containing 1.0 to 3.5% Cr as an essential component. US '322 discloses 1.0 to 3.5% to Cr at Col. 4, line 29, Col. 6, lines 40-50, and independent claims 1 and 4. In addition, all steel types of the

examples of US '322 in Table 1 at Cols. 11-12 of US '322 disclose more than 1.0% Cr except steel type A13. Steel type A13 is identified as conventional steel (not the steel of the technology of US '322) which contains 0.68% Cr (greater than 0.5 Cr) and 1.86% Mn (greater than 1.60% Mn). The specification of US '322 states at Col. 6, lines 40-44:

> Cr is essential to the present invention in which a long pipe is quenched by cooling at a cooling rate corresponding to that of air cooling with distortions caused by quenching being greatly suppressed compared with those caused by water quenching.

In the present invention, Cr is an arbitrary component of the steel pipe composition, and if Cr is present in the composition of the steel pipe, the present invention limits the Cr content to not more than 0.5%. That is, the minimum essential Cr of US '322 (1.0% Cr) is twice as much as the maximum optional or arbitrary Cr (0.5%) permitted by the present invention.

Air Cooling

As noted above, US '322 at Col. 6, lines 40-44 clearly teaches air cooling and clearly teaches against water quenching. The essential Cr of US '322 is directly linked by the disclosure of US '322 to the cooling of a heat treated pipe by a cooling rate in a range provided by air cooling.

In contrast, the heat treated steel pipe of the present invention is water quenched. Water quenching of the present invention is directly related to the very high tensile strength (TS) and low yield rate (YR) of the present invention. The water quenching of the present invention results in the very high dislocation density of the present invention, 10^{10} to 10^{14}/mm^{-2}, which results in the very high tensile strength (TS) of the present invention.

US '322 teaches air cooling and teaches against water quenching throughout the specification of US '322. For example, US '322 states at Col. 1, lines 11-15:

> Instead of quenching following finish forming, normalizing can be applied to the steel member of this invention so as to achieve high strength and improved toughness, and therefore quenching distortion does not occur.

Normalizing is air cooling. The technology of US '322 is directed to air cooling and not water quenching.

US '322 further states at Col. 3, lines 38-57:

> It has been thought that it is advantageous to employ an as-quenched material in order to provide a steel member with a high strength at low costs. For this purpose it has been known to utilize water-quenching followed by tempering at a temperature as low as 200°C or less. However, water-quenching results in relatively large distortions which must be recovered at a later state. Furthermore, when the strength of the steel member is high, cracking and buckling, for example, occur with a degregation in accuracy in size during recovery of the distortions, making the recovery rather difficult from a practical viewpoint. Thus, from a practical viewpoint it is desirable that quenching be carried out by air cooling.
>
> According to the findings of the present inventors, it is possible to carry out quenching by air cooling when a steel composition is adjusted to a suitable one, particularly when the banite index is restricted to 0-50% and a steel member having a high strength and toughness with a low yield ratio can be obtained.

Col. 8, lines 8-9 of US '322 states that the steps within box in Fig. 1 are essential steps to the invention of US '322. Fig. 1 of US '322 disclose "Air Hardening" in a box. Thus, air cooling is taught as essential to the technology of US '322.

US '322 at Col. 5, lines 15-16 provides an equation (3) for calculating the cooling rate R. By calculation, the maximum cooling rate R is about 500°C/min. The maximum cooling rate actually used in the Examples of US '322 is at Table 5, Steel Type

B10, cooling rate R = 300°C/min and Table 7, Steel Type B10, cooling rate R = 300°C/min. The maximum calculated cooling rate in the Examples of US '322 is at Table 3, Steel Type A10, and Table 5, Steel Type A10, calculate maximum cooling rate R = 498°C/min. Note: These examples are identified as "conventional".

The present invention employs a water quenching cooling rate of about 6,000°C/min (100°C/sec) or higher. See specification page 9, line 37 to page 10, line 3. The water quenching of the present invention is essentially for achieving the very high tensile strength (TS) of the present invention. This has been previously discussed in detail. See specification page 9, line 14 to page 10, line 9. Table 2 at page 14 of the specification disclose cooling rates for the Inventive Examples of the present invention ranging between 150 to 200°C/sec (9,000 to 12,000°C/min).

US '322 clearly teaches air cooling of a heat treated steel pipe and clearly teaches away from water quenching of heat treated steel pipes. The cooling rates disclosed in US '322, in the parameter °C/min, are not comparable to the water quenching cooling rates, 6,000°C/min or higher, used in the present invention.

The water quenching of the present invention is required to achieve the very high tensile strength (TS) in combination with low yield ratio (YR) using the steel composition in accordance with the present invention.

<u>Examples of US '322 - Tensile Strength</u>

The examples of US '322 clearly show that US '322 cannot achieve a tensile strength (TS) of 173.9 kgf/mm^2 or greater (1700 MPa or greater) with a steel pipe having a composition as defined in independent claims 1 to 4.

The compositions of the steel pipes used in the examples of US '322 are listed in Table 1 of US '322.

The following is a listing of steel pipes of US '322 having a tensile strength (TS) of 173.9 kgf/mm^2 or greater along with the composition of the steel pipe. The steel pipes are identified by Table number and "Steel Type".

TABLE 2 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
Al	177	2.66	1.08	-	
Bl	176	1.09	2.38	-	See C & Si
A4	186	1.53	1.89	-	
A4	205	1.53	1.89	-	
B6	183	1.35	1.55	-	
B8	185	1.92	1.95	-	

TABLE 3 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
B10	210	2.97	1.02	-	See C & Si
A12	176	1.03	1.01	1.76	

TABLE 4 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
B1	181	1.09	2.38	-	See C & Si
A4	182	1.53	1.89	-	
B6	177	1.35	1.55	-	
B8	180	1.92	1.95	-	
A9	174	1.62	1.54	-	

TABLE 5 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
B10	207	2.97	1.02	-	See C & Si
A12	193	1.03	1.01	1.76	
B1	189	1.09	2.38	-	See C & Si

TABLE 6 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
B1	178	1.09	2.38	-	See C & Si
A4	183	1.53	1.89	-	
B6	178	1.35	1.55	-	
B8	181	1.92	1.95	-	

TABLE 7 of US '322

Steel Type	TS	Mn	Cr	Mo	Note
B10	208	2.97	1.02	-	See C & Si
A12	176	1.03	1.01	1.76	

It is readily apparent that any example of US '322 that has a tensile strength (TS) of 173.9 kgf/mm^2 or greater has a composition that is outside the composition of the steel pipe of the present invention as defined in independent claims 1 to 4.

US '322 does not disclose or suggest the steel composition of the present invention. US '322 teaches that 1.0 to 3.5% Cr is essential in the steel composition. In the present invention, Cr is an arbitrary component in the steel composition, and if present, Cr is limited to not more than 0.5%.

US '322 teaches air cooling and teaches against water cooling. In the present invention, water cooling is required to achieve the very high dislocation density of 10^{10} to

$10^{14}/mm^{-2}$. As previously discussed in detail, the very high dislocation density of the present invention is directly related to the very high tensile (TS) and low yield ratio (YR).

US '322 does not disclose or suggest a steel pipe having the composition defined in independent claims 1 to 4 and having a tensile strength (TS) of 173.9 kgf/mm^2 (1700 MPa) or greater. US '322 does not disclose or suggest how to make a steel pipe with the steel composition defined in independent claims 1 to 4 having a tensile strength (TS) of 173.9 kgf/mm^2 (1700 MPa) or greater because US '322 does not disclose or suggest water quenching of a heat treated steel pipe having a steel composition in accordance with the present invention. US '322 teaches air cooling a heat treated steel pipe which does not have the defined steel composition of the present invention.

US '322 does not disclose or suggest the very high dislocation density of 10^{10} to $10^{14}/mm^{-2}$ of dependent claim 6. The very high dislocation density of the present invention is the result of water quenching and the very high dislocation density of the present invention results in the very high tensile strength (TS) and low yield ratio (YR) of the present invention. US '322 teaches air cooling of a heat treated steel pipe and teaches away from water quenching.

SUMMARY OF PATENTABILITY

In view of the reasons set forth in the foregoing Interview Summary, it is submitted that amended independent claims 1 to 4, and all claims dependent thereon, are patentable over Japan No. 6-179945. JP '945 does not disclose or suggest a steel pipe having the claimed composition in combination with the claimed tensile strength (TS) of amended independent claims 1 to 4.

In view of the reasons set forth in the foregoing Interview Summary, it is submitted that amended independent claims 1 to 4, and all claims dependent thereon, are

patentable over U.S. Patent No. 5,374,322 to Okada et al. US '322 does not disclose or suggest a steel pipe having the claimed composition in combination with the claimed tensile strength (TS) of amended independent claims 1 to 4.

Dependent claim 6 is further patentable because neither JP '945 nor US '322 disclose or suggest the high dislocation density of 10^{10} to $10^{14}/mm^{-2}$ of dependent claim 6. The high dislocation density of dependent claim 6 is the result of water quenching and is directly related to the high tensile strength (TS) of the present invention. JP '945 and US '322 teach air cooling.

Dependent claims 9 and 14 are further patentable because neither JP '945 nor US '322 disclose or suggest 95% or more martensite in the microstructure of the steel pipe.

Dependent method claims 11 to 14 are further patentable because they all expressly require water quenching. JP '945 and US '322 both teach air cooling.

CONCLUSION

In view of the present amendment, the foregoing remarks, and the discussion at the interview, it is submitted that the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

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